Proposed Plan to Amend the Record of Decision (August 1, 1990)
for the PCB Areas Operable Unit
Crab Orchard National Wildlife Refuge Superfund Site, Marion, Illinois

INTRODUCTION

This Proposed Plan identifies the Preferred Alternative for addressing Plume 2 groundwater contamination at the Polychlorinated Biphenyl Areas Operable Unit (PCB OU) within the Crab Orchard National Wildlife Refuge Superfund Site, Marion, Illinois. This document also explains the United States Environmental Protection Agency's (U.S. EPA) recommended change to the cleanup plan for the groundwater contamination that U.S. EPA initially described in the June 23, 2000 Explanation of Significant Differences (ESD) to the 1990 Record of Decision (ROD) for the PCB OU. In addition, this Proposed Plan includes summaries of other cleanup alternatives evaluated for use at this site.

As provided in the September 1991 Federal Facilities Agreement signed between the U.S. EPA, Illinois EPA, U.S. Department of the Interior (DOI), and the U.S. Department of the Army, the U.S. EPA is the lead agency for implementing the cleanup activities required for the PCB OU. The U.S. Department of the Interior/Fish and Wildlife Service (FWS), and the Illinois EPA are the support agencies. U.S. EPA, in consultation with the support agencies will select a final remedy for the site after reviewing and considering all information submitted during the 30-day public comment period. U.S. EPA, in consultation with the support agencies may modify the Preferred Alternative or select another response action presented in this Plan based on new information or public comments. Therefore, the public is encouraged to review and comment on all the alternatives presented in this Proposed Plan.

U.S. EPA is issuing this Proposed Plan as part of its public participation responsibilities under Section 300.435(c)(2)(ii) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This Proposed Plan summarizes information that can be found in greater detail in the July 2012 Focused Feasibility Study (FFS) Report (revision 4) for Plume 2 at the PCB OU Site 33 and other documents contained in the Administrative Record file for this site. U.S. EPA, FWS, and Illinois EPA encourage the public to review these documents to gain a more comprehensive understanding of the site and Superfund activities that have been conducted at this site.

SITE BACKGROUND

a. Site History:

The Crab Orchard National Wildlife Refuge (the Refuge) is located approximately 5 miles west of Marion, Illinois in Williamson County. The Refuge (Figure 1) is also used for recreational, agriculture and industrial purposes. The western end of the Refuge around Crab Orchard Lake is used for recreational purposes while the eastern end is used for manufacturing facilities. Access to the eastern portion is closed to the public, except for limited access to workers at the industrial sites and restricted access to hunters.

In the early 1940's, the War Department, the predecessor to the Department of Defense (DOD), used the area at the east end of Crab Orchard Lake, for the manufacturing of bombs, land mines, and explosives. Manufacturing stopped at the end of World War II. The War Assets Department transferred administration of the area to DOI in 1947, with the exception of the ammonia nitrate plant (which was transferred to DOI in 1951) for use as a National Wildlife Refuge. The enacting legislation, which created the Refuge, required DOI to continue leasing former wartime industry buildings to industrial tenants. The industrial manufacturing operations, which continue to the present, included at various times ammunition and explosives, metal fabrication, plating, and manufacturing of printing inks, fiberglass boats, and electrical components. Over the years these tenants have disposed of their waste at several areas within the Refuge.

Tests performed in the eastern portions of the Refuge during the late 1970s and early 1980s indicated that contaminants such as PCBs, lead, and cadmium were present. Based on these findings and the potential threat of these contaminants to human health and the environment, U.S. EPA placed the Crab Orchard Site on the National Priorities List (NPL) in July 1987. The FWS, an agency of the U.S. Department of the Interior administers the Refuge. Affected areas within the Refuge are currently divided into seven separate operable units (OUs). These operable units are the Metals Areas OU, the PCB Areas OU, the Explosives/Munitions Manufacturing Areas OU, the Miscellaneous Areas OU, the Water Towers OU, the Additional and Uncharacterized Sites OU, and the Lake Monitoring OU.

b. <u>Record of Decision (August 1990)</u>:

The PCB OU included four distinct sites which contained soil and sediment contaminated primarily with PCBs, lead, and cadmium. These sites were the Job Corps Landfill Site (Site 17), the Water Tower Landfill Site (Site 28), Area 9 Landfill (Site 32), and the Area 9 Building Complex (Site 33). U.S. EPA signed a Record of Decision (ROD) for the PCB OU in August 1, 1990. The ROD selected the excavation, treatment, and on-site disposal of soil and sediments contaminated with PCBs, lead, and cadmium at the PCB OU. Schlumberger Industries Inc., now known as Schlumberger Technology Corporation (Schlumberger), as the Settling Defendant under the terms of a Consent Decree (May 13, 1991) signed with U.S. EPA and DOI, conducted the cleanup activities required in the ROD. Approximately 117,000 tons of soil and sediments contaminated with PCBs with concentrations greater than 25 mg/kg were incinerated in an on-site thermal treatment unit. Soil contaminated with lead and cadmium with levels greater than 450 mg/kg and 10 mg/kg respectively, were stabilized/solidified, as necessary, to render them non-hazardous and disposed of in an on-site landfill. Soil and sediments contaminated with PCBs with levels less than or equal to 25 mg/kg were excavated, consolidated, and backfilled in an on-site repository. Schlumberger completed these cleanup activities in 1997.

In addition to the cleanup actions selected for the PCB OU, the 1990 ROD required that the groundwater at the cleaned up sites be monitored during and after construction of the remedial action. The purpose was to ensure that after completion of the remediation of the contaminated soils and sediments, the risk from all of the contaminants in the groundwater (measured at the source of contamination) above naturally occurring background levels shall not exceed any excess human health risk or any standard. If, at any time, groundwater at any of the remediated sites exceeds a 10^{-6} cumulative life-time cancer risk, or maximum contaminant levels (MCLs) for carcinogens, whichever is more stringent; and MCLs, maximum contaminant level goals (MCLGs), or a hazard index of 1.0, whichever is more stringent for non-carcinogens; the ROD required U.S. EPA to determine additional remedial work to be performed at the PCB OU.

c. Explanation of Significant Differences (June 2000):

The groundwater monitoring activities conducted by Schlumberger indicated the presence of trichloroethylene (TCE) and other chlorinated solvents at levels far exceeding their respective MCLs at Sites 32/33. Schlumberger conducted a groundwater investigation at Sites 32/33 in 1997 and 1998 and prepared a Groundwater Investigation and Focused Feasibility Study Report (GWI/FFS) to address groundwater contamination. Although TCE contamination was known to exist at the time of the ROD, the GWI discovered levels of TCE in groundwater as high as 66,000 parts per billion (ppb) or over 10,000 times the MCL of 5 ppb listed in the Safe Drinking Water Act. In addition to the TCE contamination, other chlorinated volatile organic compounds (CVOCs) including tetrachloroethene (PCE), dichloroethene (DCE), and vinyl chloride were also discovered at levels above their respective MCLs. The GWI identified five separate known and potential CVOC source areas and associated groundwater plumes within the remediated sites 32/33. These areas include Building I-1-23, Building I-1-2/I-1-3, Building I-1-36A, Area 9 Repository, and an area south of the Repository. These five source areas produce three separate groundwater plumes. The Building I-1-23 and Building I-1-2/I-1-3 source areas each produce separate plumes known as Plumes 1 and 2, respectively. The contaminated groundwater emanating from the Repository, Building I-1-36A, and the area south of the Repository merges into a common plume known as Plume 3 (Figure 2).

In June 2000, U.S. EPA issued an Explanation of Significant Differences (ESD) for the PCB OU and selected multiphase extraction (MPE) with limited phytoremediation and monitored natural attenuation as the appropriate remedial technology for groundwater remediation premised on source material removal. The remedy selected in the ESD was based on the assumption that the hydro-geological strata were similar in all of the source areas requiring remediation.

BASIS FOR AMENDING THE ROD

Schlumberger conducted a pre-design investigation to further characterize the source areas at the PCB OU. The results of the investigation confirmed the presence of the three major plumes in the groundwater. The investigation concluded that the hydro-geological strata near the Building I-1-23 source area consisted of approximately 15 feet of an Upper Sand unit in between an Upper Clay and a Lower Clay unit, whereas near the Building I-1-2/I-1-3 source area, the Upper Sand unit between the Upper and Lower Clay units is either missing or discontinuous. The absence of the sand layer in the Building I-1-2/I-1-3 source area makes it difficult to achieve the remedial action objectives using the multiphase extraction technology without further enhancement. The physical differences among the separate CVOC source areas, and the expected difficulties in achieving the desired level or remediation effectiveness using MPE technology as specified in the ESD, were sufficiently significant to warrant reevaluation of remedial alternatives for the separate primary source areas. Amendment to the ROD/ESD was necessary. The FFS Report (Revision 3) dated August 2004 reevaluated various alternatives to address the groundwater contamination at Plumes 1, 2, and 3.

AUGUST 2007 ROD AMENDMENT TO ADDRESS GROUNDWATER CONTAMINATION AT PLUMES 1 & 3

In April 2006, U.S. EPA issued a proposed plan to modify the groundwater cleanup actions required in the June 2000 ESD for the PCB OU. Based on public comments, and comments received from the support agencies (Illinois EPA and FWS), U.S. EPA signed an amendment to the 1990 ROD and the 2000 ESD on August 7, 2007. This ROD Amendment addressed the following groundwater cleanup actions for Plumes 1 and 3 only.

- Plume 1 (Groundwater Plume near Building I-1-23) – Excavation and off-site disposal of CVOC-contaminated soil to 1 mg/kg CVOC contour in the Upper Clay unit, groundwater extraction and treatment in the Sand unit beneath the Upper Clay, and Phytoremediation.
- Plume 3 (Groundwater Plume formed from the sources at the Repository, Building I-1-36A, and south of the Repository) – Phytoremediation and Monitored Natural Attenuation.
- Institutional Controls to prohibit the installation of potable water wells until the groundwater is restored to the drinking water standards.

For Plume 2 (Groundwater Plume near Building I-1-2/I-1-3), U.S. EPA had initially chosen Electric Resistive Heating (ERH) and Institutional Controls as its preferred remedy. This remedy involved the use of electric current transmitted through the contaminated soil in the Upper Clay and the Upper Sand units, using a large number of metal electrodes to heat the groundwater in the vicinity of Buildings I-1-2/I-1-3 to the boiling point, and removal of the resulting steam and hot soil vapor using the vapor extraction system. However, FWS raised several concerns relating to the safety of the employees working in the nearby buildings. They also raised concerns about potential detrimental effects of stray voltage from the ERH system on the highly explosive finished military ammunitions stored in Buildings I-1-2 and I-1-3. For these reasons, U.S. EPA chose to postpone selecting a remedy for addressing the groundwater contamination at Plume 2 until DOI's concerns are addressed. This Proposed Plan pertains to the groundwater contamination at Plume 2 only.

SITE CHARACTERISTICS

a. Site Setting

The Crab Orchard National Wildlife Refuge (Figure 1) is located in Southern Illinois, just south and west of the city of Marion. It is near the center of the southern tip of the state, with the Mississippi River approximately 25 miles to the west and the Ohio River approximately 55 miles to the east. The Refuge comprises an area of approximately 43,500 acres of forested land, pine plantations, and cultivated lands. A portion of the Refuge is set aside for industrial purposes. Three lakes are located within the Refuge, including the Crab Orchard Lake, a 7,000–acre man-made reservoir. The western portion of the Refuge around Crab Orchard Lake is open to public use for recreational purposes, while the eastern portion of the Refuge is a wildlife sanctuary that is closed to general public access. Land around the eastern portions of Crab Orchard Lake is also used for industrial purposes.

The construction of Crab Orchard Lake was completed in 1940 as part of The Crab Orchard Project for Land Utilization. The dam that impounds the waters of Crab Orchard Creek and its tributaries, creating Crab Orchard Lake reservoir, is located at the extreme western end of the lake and has a spillway elevation of 405 feet above mean sea level (MSL). Crab Orchard Lake is approximately nine miles long and varies in width from approximately 1.5 miles in the west near the dam to approximately 0.5 mile in the eastern end. The average water depth varies over the area of Crab Orchard Lake from approximately two to nine feet with a maximum depth of 30 feet. The majority of the northern boundary of the PCB OU area terminates at a bay on Crab Orchard Lake.

b. Site Geology:

The site geology near Buildings I-1-2 and I-1-3 is composed of unconsolidated sediments and residuum that resides above shallow bedrock. There are four hydrostratigraphic units within the overburden: Upper Clay, Upper Sand, Lower Clay, and Lower Sand. Beneath the unconsolidated overburden lies Pennsylvanian-aged sandstone from the Tradewater Formation.

Upper Clay Unit

The Upper Clay unit is present from the ground surface to between 17 to 26 feet below ground surface (bgs) approximately 400 to 410 feet above MSL with the exception of fill areas near ground surface as a result of excavation activities.

The lean clay is predominantly brown with some sporadic light gray and black soil mottling; is typically firm to stiff; and exhibits low to medium plasticity. The lean clay is relatively featureless and massive. The lean clay also contains varying amounts of silt, gravel and sand that forms thin two to three inch seams, and one to two feet discontinuous lenses with clayey sand and silty sand. The clay is fractured throughout but has low permeability overall. Slug test data indicates that the hydraulic conductivity of the unit within the source area is on the order of 10^{-5}

to 10^{-6} centimeters per second (cm/sec), which is consistent with silt or loess deposits. The general composition, structure, and hydraulic conductivity value of the Upper Clay unit indicates that the unit is likely a weathered loess deposit.

Upper Sand Unit

The Upper Sand (where present) underlies the Upper Clay Unit. The Upper Sand is present at elevations between 396 to 410 feet above MSL and varies in thickness from one-half to two feet thick in the Building I-1-3 area and from zero to 14 feet thick in the Building I-1-2 area. The unit pinches out east of Building I-1-2. The decreasing thickness of the unit east of Building I-1-3 area indicates that the unit may pinch out laterally to the east-northeast.

The Upper Sand unit is predominantly brown to yellowish brown in color. The sand is typically well-graded, fine to coarse grained sand in southern portion of the source area near Building I-1-2 and very fine to fine grained silty and clayey sand in the northern portion of the source area near Building I-1-3. Slug test data indicates that the hydraulic conductivity of the unit within the source area is on the order of 10^{-4} cm/sec, which is consistent with silty sands, clayey sands, and fine sand deposits. The general composition, structure, and hydraulic conductivity value of the Upper Sand unit indicates that the unit is likely a glacier outwash deposit.

Lower Clay Unit

The Lower Clay unit resides below the Upper Sand unit or the Upper Clay unit (if the Upper Sand is not continuous in this area). The Lower Clay unit is present at elevations between approximately 375 and 406 feet above MSL and varies in thickness from nine to 28 feet thick in Building I-1-3 source area to three to eight feet thick in the Building I-1-2 source area. The thickness of the unit decreases to the south as the top of bedrock elevation increases toward ground surface.

The Lower Clay is typically either brown or yellowish brown at the top of the unit and either brown or gray at the base of the unit. The lean clay is relatively featureless, massive stiff to hard, and exhibits medium plasticity. The clay contains varying amounts of silt and sand that forms thin two to three inch seams, and one to three feet thick discontinuous lenses of clayey sand and silty sand. Small angular gravel clasts of the underlying sandstone, limestone, and coal are sporadically spread throughout the unit. Slug tests from outside of the source area indicate that the hydraulic conductivity of the unit is on the order of 10^{-6} cm/sec, which is consistent clay deposit. The general composition, structure, and hydraulic conductivity value of the Lower Clay unit indicates that the unit is representative of Illinoisan glacial till.

Lower Sand Unit

The Lower Sand is only present in the Building I-1-3 area. The unit is present at elevations within the source areas between approximately 383 to 390 feet above MSL and varies in thickness from four feet thick on the east side of the building to seven feet thick immediately west side of the building.

The Lower Sand is a mixture of brown, light gray, and gray in color. The sand is composed of medium to course-grained sand and contains trace amounts of clay and silt. Slug tests from outside of the source area indicate that the hydraulic conductivity of the unit is in the order of 10^{-3} to 10^{-4} cm/sec, with is consistent with poorly-graded sand deposits. The general composition, structure, and hydraulic conductivity value of the Lower Sand unit indicates that the unit is likely either a glacial outwash deposit or a reworked deposit derived from the underlying sandstone bedrock.

Bedrock

Bedrock beneath the overburden within the potential source areas is composed primarily of Pennsylvanian-aged sandstones from the Tradewater Formation. Soil borings conducted during investigations first encountered highly weathered sandstone at the overburden/bedrock interface and then competent sandstone immediately below the weathered sandstone. The weathered sandstone is brown to light highly weathered sandstone at the overburden/bedrock interface and then competent sandstone immediately below the weathered sandstone. The weathered sandstone is brown to light yellowish brown in color and is composed of fine- and medium-grained sands that are moderately cemented, highly micaceous, and exhibit thin laminar-bedding planes. The weathered sandstone is extremely friable near the overburden/bedrock interface and increases in strength with depth. Typically within less than one foot of the overburden/bedrock interface, the sandstone transitions from brown to light gray in color, from moderately cemented to well cemented, and from easily friable to hard and competent. The physical characteristics of the sandstone identified in the soil boring logs within the potential source areas are similar to the physical characteristics of the Granger Sandstone Member of the Tradewater Formation.

Bedrock surface occurs at elevations within the potential source areas from approximately 375 feet to 398 feet above MSL. In the southern portion of the source area near Building I-1-1 and Building I-1-2, the top of the bedrock surface ranges from 28 to 38 feet bgs. In the northern portion of the potential source areas near Building I-1-3, the top of the bedrock surface ranges from 38 to 49 feet bgs. Topographically, the top of the bedrock surface within the source area slopes downward to the north, east, and west.

c. Groundwater Flow Characteristics:

The hydrostratigraphy of the site is generally divided into four units: the Upper Clay unit, the Upper Sand unit, the Lower Clay unit, and the Lower Sand Unit. Shallow groundwater (Upper Clay/Upper Sand units) beneath the broad Site 33 area is affected locally by surface water drainage and by the Area 9 Repository. The general flow directions in the Upper Clay and Upper Sand units are to the north, northwest, and west. However, Buildings I-1-1, I-1-2, and I-1-3 are located upon a groundwater divide and shallow groundwater flows away from a local groundwater high. A majority of the groundwater flow is westerly, influenced by the consistent presence and increased thickness of the Upper Sand in this direction. The horizontal hydraulic gradient is rather slight in the vicinity of Buildings I-1-1, I-1-2, and I-1-3 area ranging from 0.003 to 0.006.

Groundwater in the Lower Sand unit flows to the north toward Crab Orchard Lake. The horizontal hydraulic gradient in the Lower Sand ranges from 0.0004 to 0.0005. Over most of the site, the piezometric head in the Lower Sand is generally one to three feet lower than the head in the Upper Sand, indicating a downward potential. However, near Crab Orchard Lake, this is reversed, indicating an upward potential as groundwater discharges to the lake.

d. Surface Water:

In the southwestern portion of the site, an intermittent stream that appears to originate near Buildings I-1-2/I-1-3 flows westerly toward Highway 148, passes beneath Highway 148 through a culvert pipe, and discharges into the Heron Flats impoundment area on the western side of the highway. The intermittent stream is often dry in its upper reach, except following rainfall events. The lower reach appears to be receiving groundwater inflow and is flowing over much of the year.

e. Groundwater Contaminant Source for Plume 2:

Based on the soil chemistry data, there are two separate CVOC source areas. One source area is located directly east of Building I-1-2, just south of the former location of the manufacturing building. The second source is located just east of Building I-1-3, north of the former manufacturing building. The two source areas, although separate, form Plume 2.

Soil contamination

Fourteen volatile organic compounds (VOCs) were detected in soil; 1,1,2-trichloroethane (1,1,2-TCA), 1,1-dichloroethane (1,1-DCE), acetone, chlorobenzene, chloroethane, cis-1,2-dichloroethane (cis-1,2-DCE), ethylbenzene, methylene chloride, PCE, toluene, total xylenes, TCE, and vinyl chloride. The primary VOC detected in most of the samples during the investigations was TCE.

The highest TCE concentration (40 mg/kg) in the Upper Clay unit was found at a depth from 15 to 16 feet bgs on the east side of Building I-1-2. The highest TCE concentration (270 mg/kg) in the Upper Sand unit was found at a depth from 27 to 28 feet bgs on the east side of Building I-1-2. The highest TCE concentration (97 mg/kg) in the Lower Clay/sandstone interface was found at a depth of 33 feet bgs on the east side of Building I-1-2. High concentration of TCE (170 mg/kg) was found in a sand lens within the Lower Clay unit at a depth of 35 to 36 feet bgs on the east side of Building I-1-3. High concentration of TCE (150 mg/kg) was also detected in the Lower Clay unit at a depth of 40 to 42 feet bgs on the east side of Building I-1-3.

Groundwater Contamination

Nine VOCs were detected in groundwater above MCLs in the source area; 1,1,1-trichloroethane, 1,1,2-TCA, 1,1-DCE, cis-1,2-DCE, PCE, toluene, trans-1,2-dichloroethene (trans-1,2-DCE), TCE, and vinyl chloride. The VOC with the highest concentration and most widespread distribution is TCE. The highest TCE concentration (1,300,000 μg/L at the soil boring location SB-144) was detected in the Lower Clay/Sandstone interface on the east side of Building I-1-2. High concentrations of TCE (79,000 μg/L at SB-140 and 270,000 μg/L at SB-142) were also detected in the Lower Clay unit east of Building I-1-3. The high concentration of 1,300,000 μg/L of TCE is indicative of non-aqueous phase liquid (NAPL) which is a principal threat.

The Conceptual Site Model presented in the Groundwater Investigation and Focused Feasibility Report (Revision 1) and the analysis provided in the Preliminary Design Report provides the following understanding of Plume 2:

- Shallow groundwater flows generally towards the Crab Orchard Lake and discharges to swales and surface water bodies.
- Contamination has migrated both laterally and vertically within the Upper Clay unit and from the Upper Clay unit to the Upper Sand unit (where it is present).
- Contamination migration is influenced by the higher permeability of the Upper Sand unit, which acts as a preferential pathway (where it is present).
- Contamination continues to migrate laterally and vertically from the Upper Clay/Upper Sand to the Lower Clay unit. Lateral migration in the Lower Clay likely occurs through sand layers or other permeable features (such as fracture) within the clay matrix.
- Contamination that has migrated through the Lower Clay unit to the Lower Sand unit moves preferential through the Lower Sand unit in the direction of groundwater flow, which is evident in elevated concentration observed in the Lower Sand on both sides of Building I-1-3.
- Lower Sand unit was not observed near Building I-1-2, but migration of contamination was observed under the building predominantly in the Upper sand.
- The presence of TCE daughter products within the upper strata indicates biodegradation is occurring, and data from the investigation suggests the rate of biodegradation is slow.
- The highest concentration of TCE detected in groundwater was in the source area, near Building I-1-2. TCE was detected at a concentration of 1,300,000 μg/L in the Lower Clay unit near the Lower Clay/Sandstone interface. The investigation results indicate that the source area hot spot was identified based on the other locations where borings were advanced to bedrock, and there was no indication that TCE is present at concentrations near the same magnitude. Therefore, the source area hot spot is assumed to be limited to this location and a small area around this location.

PAST AND CURRENT SITE RISKS

At the time of the 1990 ROD, there were four sites (Sites 17, 28, 32, and 33) contaminated with PCBs, lead, and cadmium. The presence of these contaminants in the soil and sediment at these sites posed an unacceptable risk to human health, environment, and the wildlife at the Crab Orchard National Wildlife Refuge. Remedial action to clean up the above contaminants was completed in 1997. Remedial actions were also conducted in 2004, 2009, and 2012 to remove additional PCB-contaminated soil in the Center Swale drainage area, Tree Stand Area, the 1960s Ditch and other areas within the PCB OU.

As stated earlier, the GWI Report identified the presence of TCE and other CVOCs above MCLs in the groundwater in the vicinity of Buildings I-1-23 and I-1-2/I-1-3 and posed a risk to potential drinking water users. The 2007 ROD Amendment addressed groundwater contamination for Plumes 1 and 3 near Building I-1-23. Schlumberger, as the Settling Defendant, completed the remedial activities in 2011 to address Plumes 1 and 3 groundwater contamination. This Proposed Plan addresses remediation of Plume 2 contaminated groundwater.

REMEDIAL ACTION OBJECTIVES

40 CFR 300.430(a)(1)(iii)(F) of the National Contingency Plan (NCP) states:

> "EPA expects to return usable ground waters to their beneficial uses wherever practicable, within a time frame that is reasonable given the particular circumstances of the site. When restoration of ground water to beneficial uses is not practicable, EPA expects to prevent further migration of the plume, prevent exposure to the contaminated ground water, and evaluate further risk reduction."

The State of Illinois has determined that the contaminated aquifer is a Class I Potable Groundwater Resource. Although the groundwater at this location is currently not used for drinking water purposes, the potential future groundwater use is for drinking water purposes. The Remedial Action Objectives are as follows:

- Restore contaminated groundwater at Sites 32/33 to State of Illinois and Federal Drinking Water Standards to the extent practicable
- Reduce or control, to the extent practicable, the impact of subsurface sources of volatile organic compounds on the groundwater quality.

SUMMARY OF REMEDIAL ALTERNATIVES

All alternatives, with the exception of the No Action alternative include Long-Term Management and Institutional Controls. The following includes a brief description of various components of the remedial alternatives included in this Proposed Plan. Detailed description of these components can be found in the FFS Report (Revision 4) for the PCB OU.

No Action alternative consists of taking no action. The NCP requires that a no action alternative be retained throughout the feasibility study process as a baseline against which to compare the other alternatives. The "No Action" alternative is considered ineffective at achieving the remedial action objectives of bringing the groundwater to beneficial uses or to reduce/control the impact of subsurface sources of the VOCs on the groundwater quality.

Excavation; This alternative consists of excavation and off-site disposal of soil within the source area indicative of NAPL around SB-144, hot spot area around SB-140/SB-126, and hot spot area around SB-142 from ground surface to bedrock (Figure 3).

Soil Mixing with Zero Valent Iron (ZVI) is an in situ technology that uses a large auger system, equipped with nozzles, to add clay-granular ZVI slurry into the soil while mechanically breaking up and mixing the soil. Shallow soil mixing via the auger system, converts the source zone into a homogenous mixture of soil, clay, iron, and target contaminants by turning the auger while repeatedly cycling up and down throughout the mixing column. The ZVI degrades the CVOCs through chemical reduction and also promotes subsequent biological degradation. Also, the addition of clay and mixing of the soil column reduces the potential of contaminants to flow away from the source zone through a reduction in hydraulic conductivity.

Soil mixing component of the remedy consists of mixing soil with a clay and zero-valent iron (ZVI) mixture to treat the soil within the source area indicative of NAPL around SB-144, hot spot area around SB-140/SB-126 and hot spot area around SB-142 (Figure 4). A mix design of 2.5 percent ZVI and 1 percent bentonite is assumed for the target treatment zones.

Thermal Conductive Heating, also known as in situ thermal desorption, generates heat using electrical power, based on resistive principles. The heat generated through the process mobilizes the CVOCs which are then collected and appropriately managed. Thermal conductive heating systems consist of heater assemblies installed in the ground within sealed steel well casings, electrical power distribution equipment, vapor and groundwater extraction wells which capture mobilized CVOCs, and an aboveground plant to treat extracted process vapor and fluids. Multiple heater assemblies are placed across the treatment zone at relatively close spacing to ensure thorough conductive heating. Recovery wells are placed to capture groundwater and vapor mobilized during heating.

Thermal Conductive Heating component of the remedy consists of implementing the heating system within the source area indicative of NAPL around SB-144, hot spot areas around SB-140/SB126, and SB-142 (Figure 5).

Long-Term Management (LTM) component of the remedial alternatives includes groundwater monitoring to detect changes in groundwater contaminants of concern (COC) concentrations and manage any associated risks. A select number of existing and newly installed monitoring wells will be sampled as part of the LTM program. Proposed monitoring wells will be screened within the Upper Clay, Upper Sand, Lower Clay, and Lower Sand units. Wells will monitor the CVOC source area, along the plume centerline, downgradient of the plume, and upgradient of the TCE Plume.

Institutional Controls component of the remedial alternatives prohibits the installation of potable water wells until the groundwater is restored to the drinking water standards (Figure 6). The FWS has placed certain institutional controls at the Illinois Ordnance Plant Industrial Areas administered by FWS and other areas currently being investigated, including controls for Sites 32 and 33 of the PCB OU. These controls are documented in the April 2008 Environmental Land Use Control (ELUC) Plan prepared and enforced by the FWS. The plan prohibits the installation of production wells within the boundary of the former Illinois Ordnance Plant. However, recorded, enforceable ICs that prohibit the installation of potable wells until the groundwater is restored to drinking water standards will have to be part of any remedy chosen in order for the existing ICs to be permanent. The regulatory agencies including U.S. EPA and Illinois EPA anticipate entering into a Land Use Control Memorandum of Agreement (LUCMOA) with FWS which will ensure the durability of the ICs for Plume 2 and other sites on the refuge and which will supplant FWS's April 2008 ELUC Plan.

The following are the remedial alternatives to address Plume 2 groundwater contamination near Buildings I-1-2 and I-1-3:

Alternative 1	No Action
Alternative 2	Excavation, Long-Term Management, and Institutional Controls
Alternative 3	Soil Mixing with Zero Valent Iron, Long-Term Management, and Institutional Controls
Alternative 4	Source Area Thermal Conductive Heating, Long-Term Management, and Institutional Controls
Alternative 5	Long-Term Management and Institutional Controls

EVALUATION OF ALTERNATIVES

a. Evaluation Criteria

EPA's evaluation of remedial alternatives is based on the nine criteria set forth in the National Contingency Plan (NCP), 40 CFR Part 300. These criteria are described below.

A remedial alternative is first judged in terms of the threshold criteria of protecting human health and the environment and complying with Applicable or Relevant and Appropriate Requirements (ARARs). If a proposed remedy meets these two criteria, it is then evaluated against the balancing and modifying criteria in order to arrive at a final recommended alternative.

Threshold Criteria

1. Overall protection of human health and the environment: U.S. EPA determines whether an alternative adequately protects human health and the environment from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site.

2. Compliance with ARARs: U.S. EPA evaluates whether an alternative attains applicable or relevant and appropriate requirements under federal environmental laws and state environmental or facility siting laws or provides grounds for invoking a waiver.

Balancing Criteria

3. Long-term effectiveness and permanence: U.S. EPA considers the ability of an alternative to maintain protection of human health and the environment over time, and the reliability of such protection.

4. Reduction of contaminant toxicity, mobility, or volume through treatment: U.S. EPA evaluates the degree to which an alternative uses treatment to address the principal threats posed by the site.

5. Short-term effectiveness: U.S. EPA considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation.

6. Implementability: U.S. EPA considers the technical and administrative feasibility of implementing the alternative, such as relative availability of goods and services.

7. Cost: U.S. EPA estimates an alternative's capital and operation and maintenance (O&M) costs and calculates the present worth cost. Present worth cost is the total cost of an alternative over time in terms of today's dollars.

Modifying Criteria

8. State acceptance: U.S. EPA considers any concerns the state has raised with respect to the preferred alternative, other alternatives or with ARARs or ARAR waivers.

9. Community Acceptance: U.S. EPA considers which components of the alternatives interested persons in the community support, have reservations about, or oppose.

b. Application of the Evaluation Criteria to the Cleanup Alternatives

As part of the evaluation process, each alternative is evaluated against the nine criteria outlined above. This process of alternative evaluation is discussed in detail in the FFS Report. The Proposed Plan briefly summarizes the outcome of this evaluation with the goal of identifying the alternative that best meets the nine criteria.

Buildings I-1-2/I-1-3 Source Area and Plume 2:

1. Overall Protection of Human Health and the Environment:

All of the alternatives, with the exception of Alternatives 1, would provide adequate protection of human health and the environment. Alternative 5 provides overall protection of human health and the environment through long-term management of the dissolved TCE groundwater plume and Institutional Controls to prohibit the use of groundwater until cleanup objectives are achieved. In addition to the Long-term Management and ICs, Alternative 2 includes the excavation and off-site disposal of the contaminated soil in three hot spot areas, whereas, Alternatives 3 and 4 include treatment of the hot spot areas to remove contaminants.

2. Compliance with ARARs:

All of the alternatives with the exception of the No Action Alternative will comply with the ARARs identified in the FFS Report.

3. Long-Term Effectiveness and permanence:

Alternatives 1 and 5 will take greater than 500 years to provide long-term effectiveness and permanence because high TCE concentrations detected at the soil and bedrock interface within the source area hot spots will continue to diffuse into the groundwater. Alternatives 2, 3, and 4 provide long-term effectiveness and permanence in a shorter duration through a combination of source area hot spot removal or treatment, and natural attenuation processes.

Based on groundwater modeling results, the overall remediation time frames for all active remedial alternatives range from 75 to 280 years. The range in projected time to cleanup is a result of uncertainty as to the actual half life of TCE. The shorter time frame is based upon a shorter TCE half life (5 years) and the longer time frame is based upon a longer TCE half life (20 years). The following are the time frames for all alternatives:

- Alternative 1 --- greater than 500 years
- Alternative 2 --- 75 to 280 years
- Alternative 3 --- 75 to 280 years
- Alternative 4 --- 75 to 280 years
- Alternative 5 --- greater than 500 years

4. Reduction of toxicity, mobility, and volume through treatment:

Both Alternatives 3 and 4 are effective in reducing the toxicity, mobility, and volume of contaminants in the groundwater through treatment. Alternatives 1, 2, and 5 do not use treatment as a component of the remedy.

5. Short-Term Effectiveness:

Alternative 2 which includes excavation and off-site disposal of the contaminated soil has the highest level of potential exposure of on-site workers and the community to VOCs during implementation than other alternatives. This is due to the large volume of traffic transporting hazardous and non-hazardous waste from the excavated area to disposal facilities. Proper precautions would be taken during excavation and off-site disposal of the contaminated soil to eliminate any risk to the public and the workers from potential health risks. ICs provide short-term effectiveness by prohibiting the installation of potable water wells until the groundwater is restored to beneficial use.

Alternative 3 has the lowest short-term risk because of the relatively short duration of on-site work (two weeks of on-site construction time compared with an estimated eight weeks for Alternatives 2 and 4) and the relatively small amount of materials manufactured and transported to the site.

6. Implementability:

Alternatives 1 and 5 are easily implementable technically. All of the alternatives are easily implemented administratively.

Alternative 2 is technically feasible for removal of the source area soil. However, the depth of this excavation and presence of site encumbrances makes this alternative more difficult to implement than the other alternatives. The proximity of Building I-1-2 to the excavation requires soldier piles to be drilled into bedrock and lagging shoring to support the excavation sidewall parallel to the building. The excavation depth will require the remaining sidewalls to be benched and sloped in a manner that results in the over-excavation and disposal of a volume of soil outside the target treatment zone limits that would not require disposal or treatment under Alternatives 3 and 4. The target excavation depth extends well below the water table, presenting excavation stability hazards and technical challenges that could limit the feasibility to effectively complete the excavation to the target limits. Excavation activities associated with Alternative 2 will require more time to implement than soil mixing operations associated with Alternative 3 due to the logistics associated with excavating, handling, and transporting a large volume of soil.

Alternative 3 is technically feasible and not as logistically challenging as Alternatives 2 and 4 to implement. Soil mixing operations associated with Alternative 3 will require less time to implement than excavation activities associated with Alternative 2 and construction, operation, and maintenance activities associated with Alternative 4. The soil within the mixing area could remain structurally unstable for months to years following completion of soil mixing activities. The soil mixing area will need to be fenced off to prevent unauthorized access to or constructing on top of the soil mixing area before the soil has had time to stabilize.

Alternative 4 is technically feasible to implement at this site. A longer time will be required to finish implementing Alternative 4 within the target treatment zone than will be required for

Alternatives 2 and 3 because of the operation time associated with the treatment system. Following design and construction, the total estimated operation time is 100 days. Alternative 4 will require installation of an electric service line. The cost and time required to install temporary electric service is dependent on the ability of the existing power grid to support the system's power requirements. Unlike Alternatives 2 and 3, follow-on maintenance of the remediation system will be required. Following active treatment and shutting down of the system, the subsurface will need a cooling period before the system can be decommissioned. After adequate time has passed, the process equipment will be demobilized and the associated infrastructure will need to be abandoned.

7. Cost:

The estimated capital, annual O&M, and present worth cost for each of the alternatives has been calculated for comparative purposes and is presented in the following table.

Summary of Estimated Costs for Each Alternative		
Alternatives	Total Capital Cost	Total Present Worth Cost
Alternative 1 No Action	---	---
Alternative 2 Excavation, Long-Term Management, and Institutional Controls	$9,708,258	$9,955,000
Alternative 3 Soil Mixing, Long-Term Management, and Institutional Controls	$1,026,010	$1,273,000
Alternative 4 Thermal Conductive Heating, Long-Term Management, and Institutional Controls	$3,710,716	$3,957,000
Alternative 5 Long-Term and Institutional Controls	$97,323	$344,000

Alternative 5 has the lowest total present worth cost and Alternative 2 has the highest. This is because Alternative 5 includes long-term management and institutional controls only, while Alternative 2 includes excavation and off-site disposal of contaminated soil in addition to the long-term management and institutional controls.

8. State Acceptance:

Illinois EPA, as a support agency may concur with the preferred remedy selected by U.S. EPA. The Department of the Interior/Fish and Wildlife Service, as a federal facility support agency, may also concur with the preferred remedy

9. Community Acceptance:

U.S. EPA will accept oral and written comments from the public on this Proposed Plan during the public meeting on May 1, 2013 and in writing throughout the 30-day public comment period that runs from April 17, 2013 through May 16, 2013.

SUMMARY OF THE PREFERRED ALTERNATIVE

Building I-1-2/I-1-3 Source Area and Plume 2

The Preferred Alternative for the Building I-1-2/I-1-3 Source Area and Plume 2 is Alternative 3 (Soil mixing with Zero-Valent Iron, Long-Term Management, and Institutional Controls).

This preferred alternative consists of mixing soil with a clay and ZVI mixture to treat the source area indicative of NAPL around SB-144, hot spot area around SB-140/SB-126, and hot spot area around SB-142. Before soil mixing commences, the top three feet of soil within the proposed mixing area will be excavated to form a temporary impoundment for material handling and mixing operations. During implementation, the soil mix rig will be tracked into position over a predesigned and surveyed grid network. To ensure uniform mixing and treatment within the soil mixing area, soil mixing columns overlap between 25 and 35 percent. The center to center assumed distance between the columns will be spaced to account for overlap of adjacent columns. Assuming a 10-foot diameter auger approximately 16 columns will be advanced to bedrock within the within the source area indicative of NAPL. Approximately, eight columns would be required of each of the two hot spot areas, SB-140/SB126 and SB-142. A mix design of 2.5 percent ZVI and 1 percent bentonite is assumed for the target treatment zoned. A bench scale study may be necessary to optimize the amount of ZVI and clay to be added during mixing. Water that collects within the bermed area will be pumped to storage tanks and subsequently treated. A detailed evaluation of the water treatment remedy will be required as part of the remedial design.

Following completion of the mixing activities, the bermed soil will be regraded across the soil mixing area. Because of the time required for the mixing soil to stabilize, a chain link fence will be installed around the mixing area to prevent unauthorized persons and vehicles from passing across the structurally unstable soil, until the soil is considered stable enough for use.

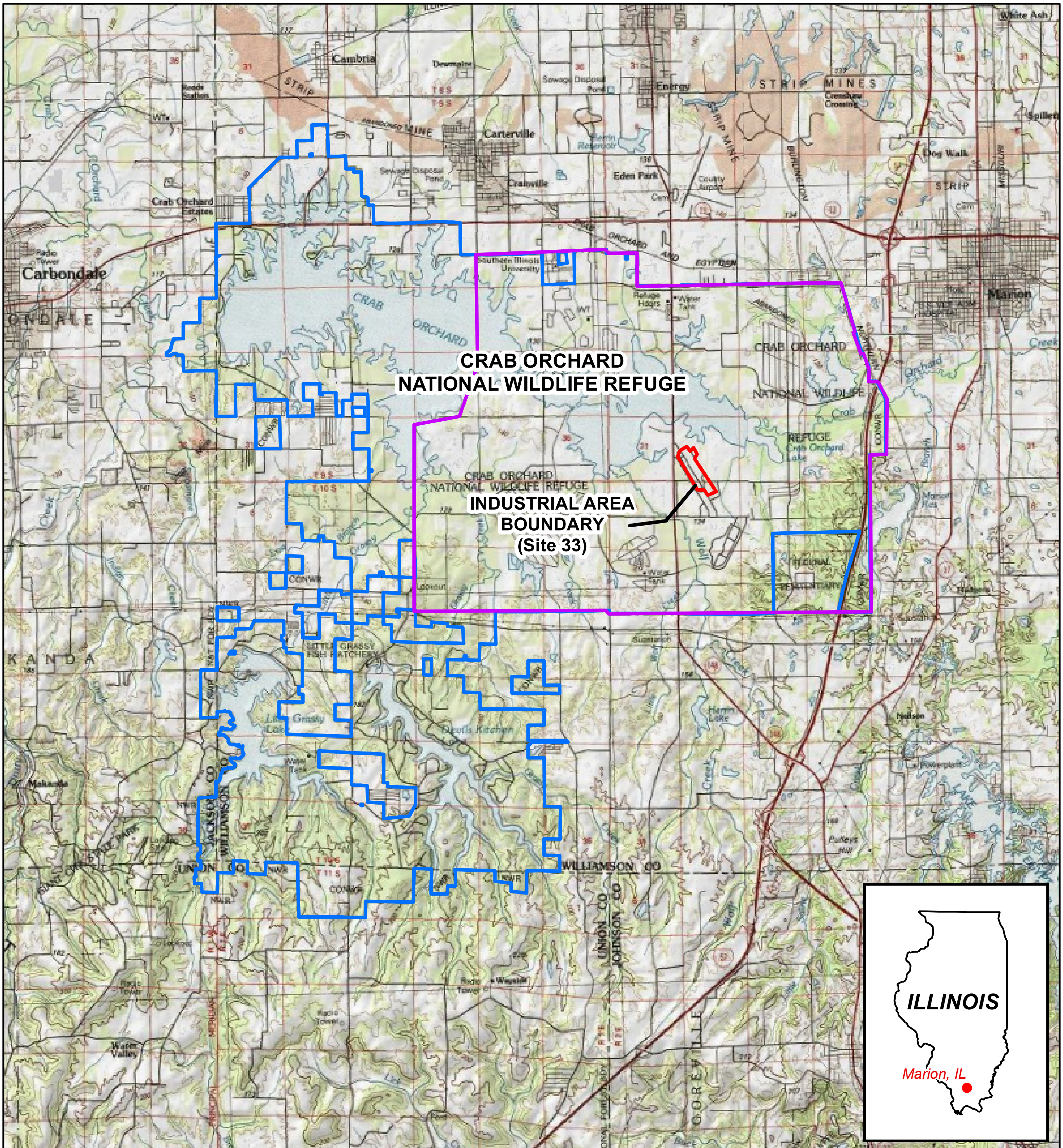
The LTM component of the remedy includes groundwater monitoring to detect changes in concentrations of contaminants in groundwater and to manage associated risks. Monitoring wells will be screened within the Upper Clay, Upper Sand, Lower Clay and Lower Sand units. These wells will be used to monitor the CVOC source area, along the plume centerline, downgradient of the plume, and upgradient of the TCE plume.

ICs component of the remedy will prohibit the installation of potable wells until groundwater is restored to drinking water standards. Currently ICs are in place and are being enforced by the FWS. These ICs will be augmented with additional, updated enforceable ICs. The regulatory agencies (U.S. EPA and Illinois EPA) anticipate entering into a LUCMOA with FWS which will ensure the durability of the ICs for Plume 2 and other sites on the refuge and which will supplant FWS' April 2008 ELUC Plan.

This alternative was selected over other alternatives because it provides adequate overall protectiveness of human health and the environment; complies with ARARs; has better effectiveness than other alternatives; satisfies preference for treatment; and has lower present worth cost of $1,273,000 when compared with other active alternatives 2 and 4.

COMMUNITY PARTICIPATION

U.S. EPA, Illinois EPA, and FWS provide information regarding the cleanup of the PCB OU within the Crab Orchard National Wildlife Refuge Superfund Site to the public through public meeting on May 1, 2013, the Administrative Record file for the site, and announcements published in Marion Daily Republican and Southern Illinoisan Newspapers. U.S. EPA, Illinois EPA, and FWS encourage the public to gain a more comprehensive understanding of the site and the Superfund activities that have been conducted at the site.



LEGEND

Crab Orchard National Wildlife Refuge

Former Illinois Ordnance Plant Boundary (Groundwater Production Well Land Use Control Boundary)

Industrial Area Boundary

N

0 6,000 12,000 Feet

Figure 1
Crab Orchard National Wildlife Refuge
Location Map
Marion, IL

Source: USA Topo Map (National Geographic Society), 2011

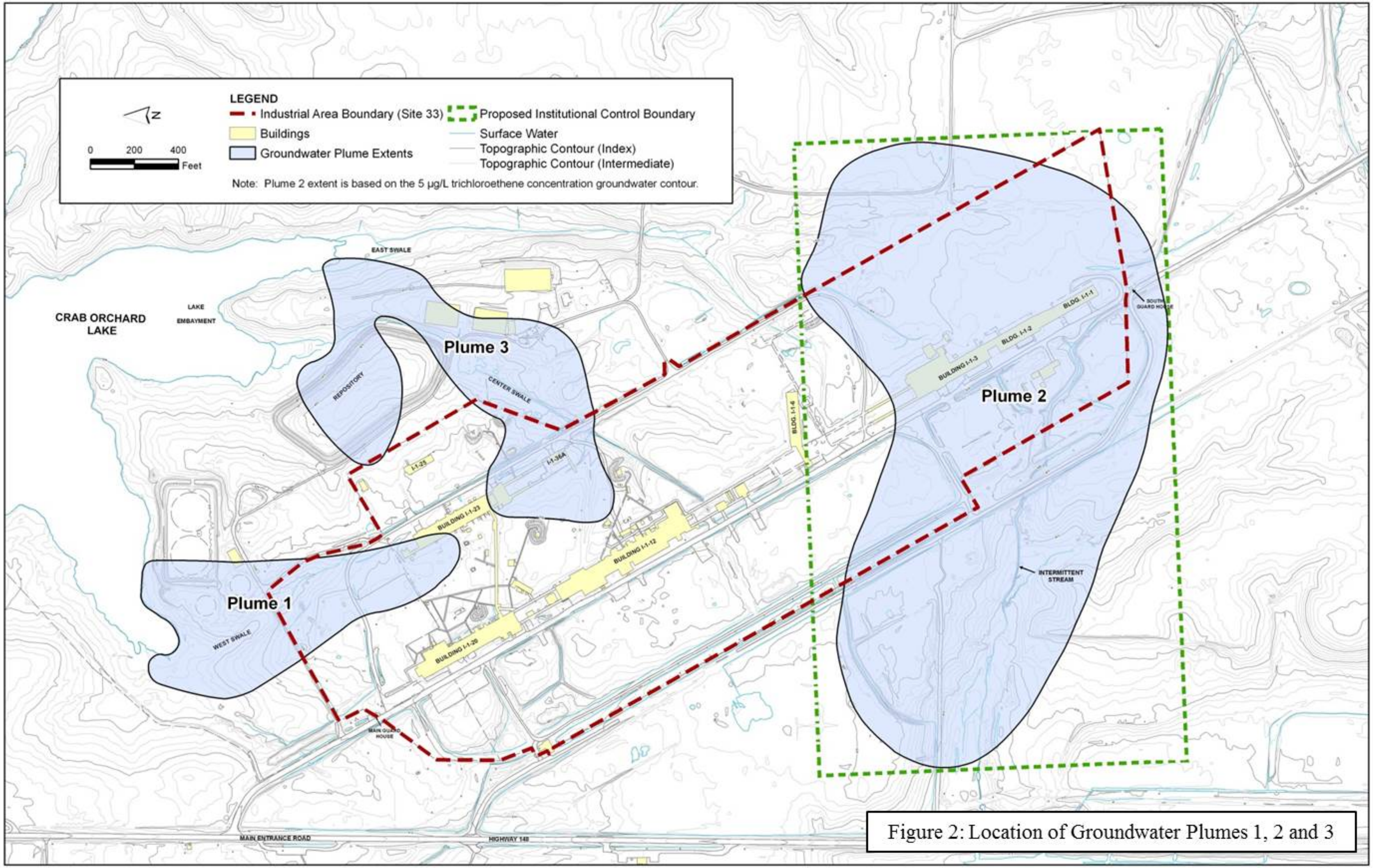


Figure 2: Location of Groundwater Plumes 1, 2 and 3

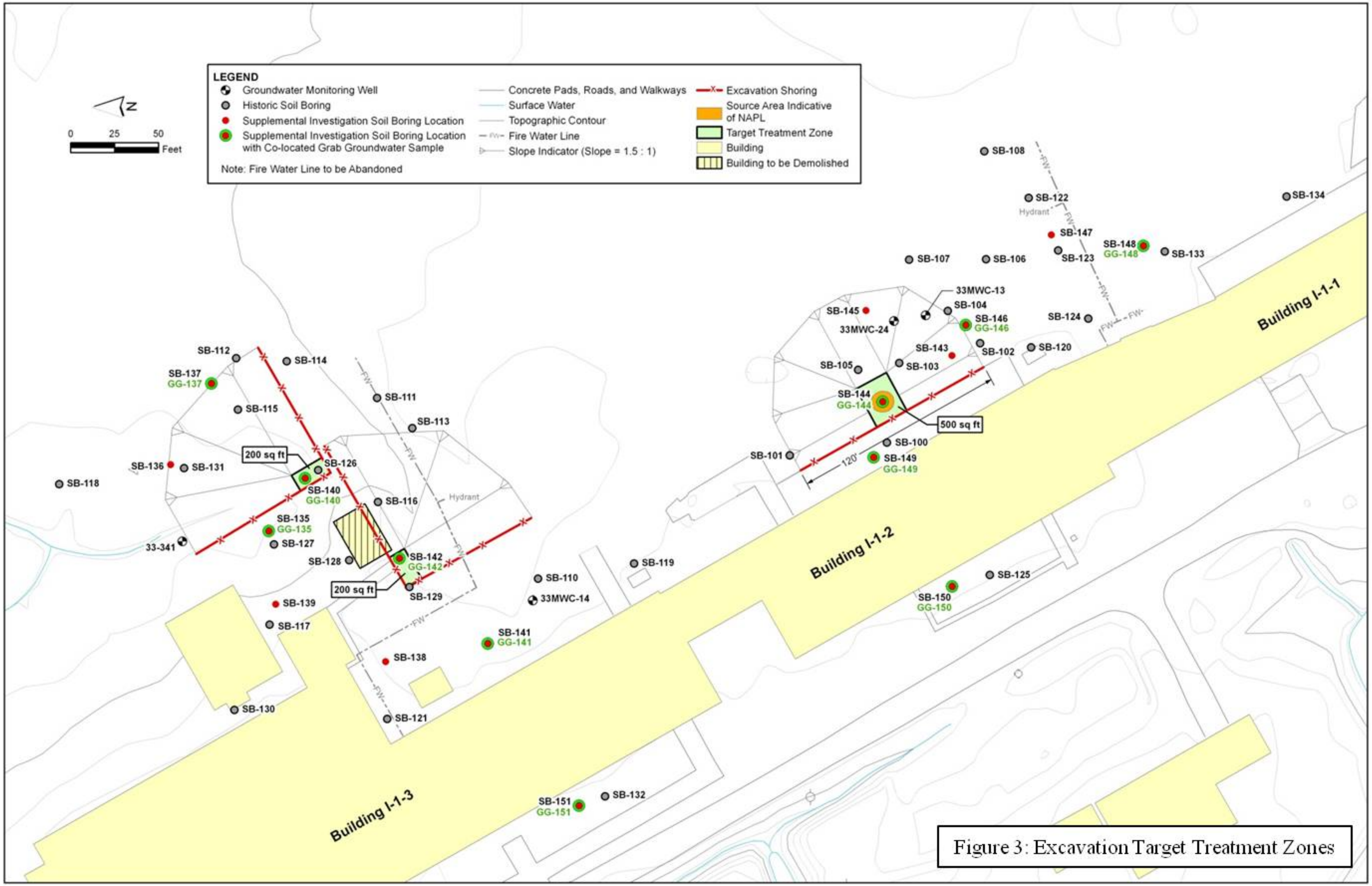


Figure 3: Excavation Target Treatment Zones

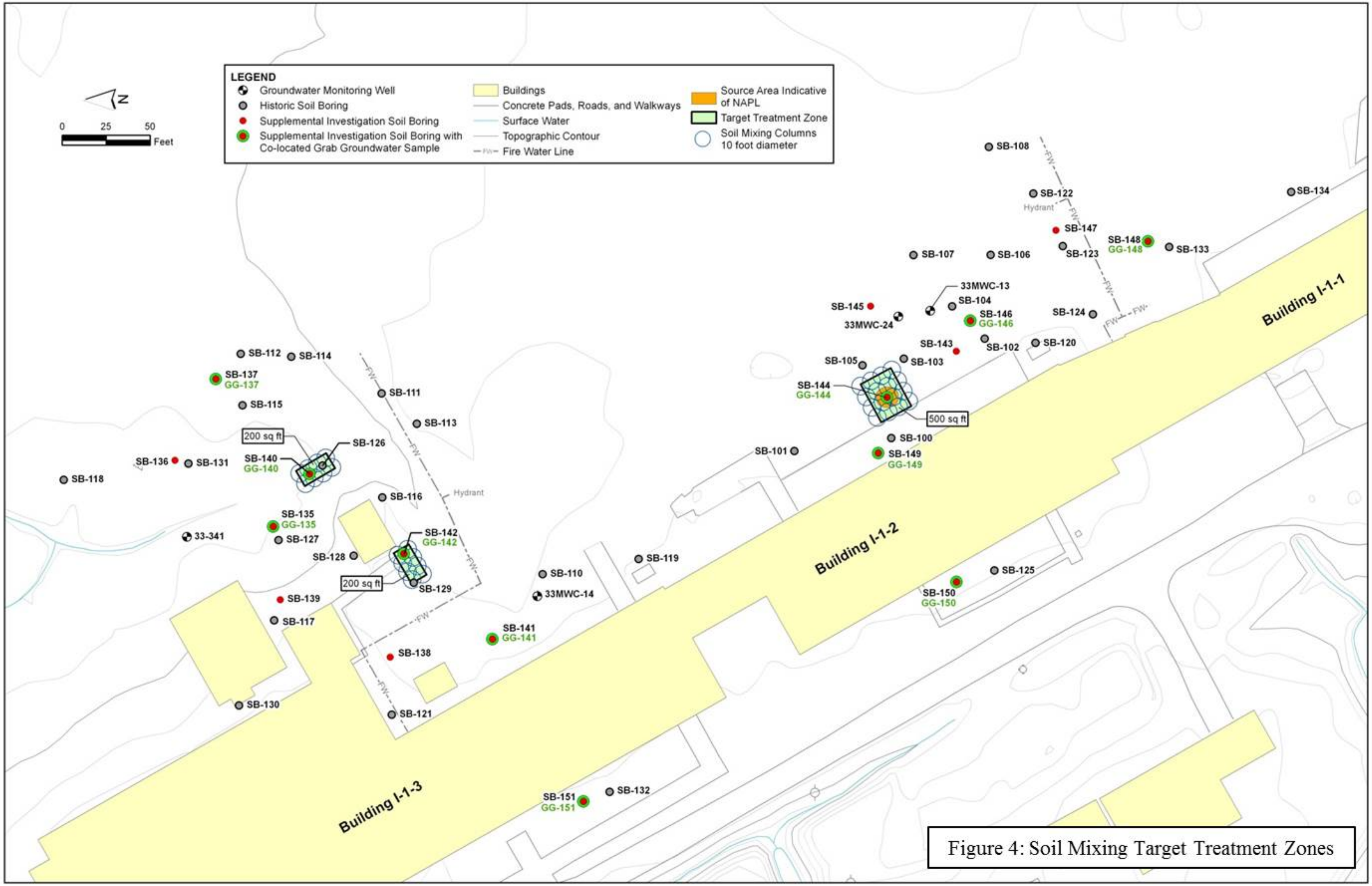


Figure 4: Soil Mixing Target Treatment Zones

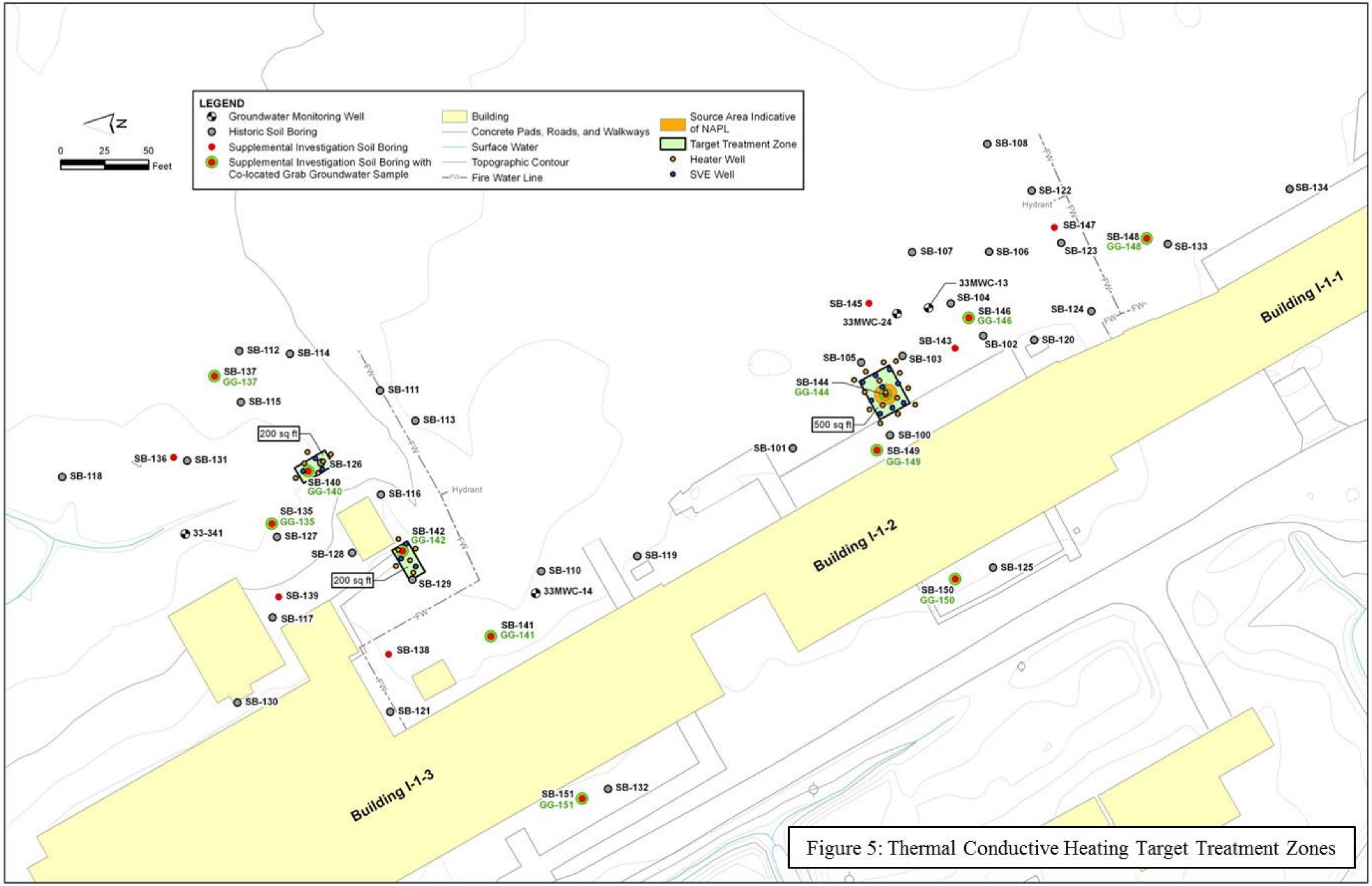


Figure 5: Thermal Conductive Heating Target Treatment Zones

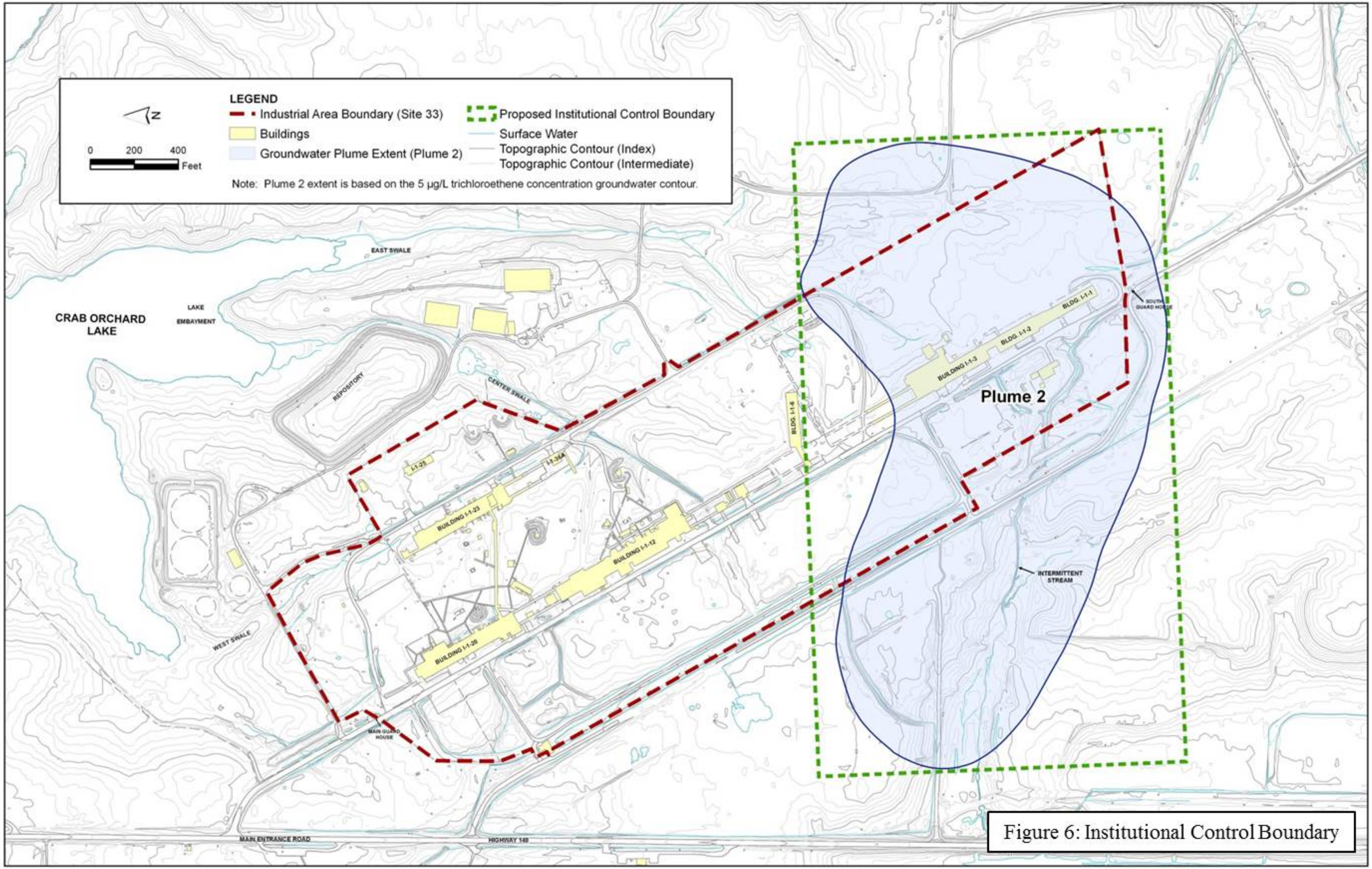


Figure 6: Institutional Control Boundary